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```
;; An exercise in reverse Polish notation evaluation suggested
;; by Damir Jamsek.
```

EVENT: Start with the initial **nqthm** theory.

DEFINITION:

```
length(l)
=  if listp(l) then 1 + length(cdr(l))
    else 0 endif
```

DEFINITION: OP1 = '(suc)

DEFINITION: OP2 = '(add mul div mod)

DEFINITION:

```

op1-form-p (e)
= (listp (e)
   ^ listp (cdr (e))
   ^ (caddr (e) = nil)
   ^ (car (e) ∈ OP1))

```

DEFINITION:

```

op2-form-p (e)
= (listp (e)
   ^ listp (cdr (e))
   ^ listp (caddr (e))
   ^ (caddr (e) = nil)
   ^ (car (e) ∈ OP2))

```

DEFINITION:

```

exp-p (e)
= if e ∈ N then t
  elseif op1-form-p (e) then exp-p (cadr (e))
  elseif op2-form-p (e) then exp-p (cadr (e)) ^ exp-p (caddr (e))
  else f endif

```

DEFINITION:

```

eval-exp (e)
= if e ∈ N then e
  elseif op1-form-p (e) ^ (car (e) = 'suc)
  then 1 + eval-exp (cadr (e))
  elseif op2-form-p (e) ^ (car (e) = 'add)
  then eval-exp (cadr (e)) + eval-exp (caddr (e))
  elseif op2-form-p (e) ^ (car (e) = 'mul)
  then eval-exp (cadr (e)) * eval-exp (caddr (e))
  elseif op2-form-p (e) ^ (car (e) = 'div)
  then eval-exp (cadr (e)) ÷ eval-exp (caddr (e))
  elseif op2-form-p (e) ^ (car (e) = 'mod)
  then eval-exp (cadr (e)) mod eval-exp (caddr (e))
  else f endif

```

DEFINITION:

```

exp-to-rpn (e)
= if e ∈ N then list (e)
  elseif op1-form-p (e) then append (exp-to-rpn (cadr (e)), list (car (e)))
  elseif op2-form-p (e)
  then append (exp-to-rpn (caddr (e)),
              append (exp-to-rpn (cadr (e)), list (car (e))))
  else nil endif

```

DEFINITION:

```
eval-rpn (r, s)
=  if listp (r)
    then if car (r) ∈ N then eval-rpn (cdr (r), cons (car (r), s))
        elseif car (r) = 'suc
            then eval-rpn (cdr (r), cons (1 + car (s), cdr (s)))
        elseif car (r) = 'add
            then eval-rpn (cdr (r), cons (car (s) + cadr (s), caddr (s)))
        elseif car (r) = 'mul
            then eval-rpn (cdr (r), cons (car (s) * cadr (s), caddr (s)))
        elseif car (r) = 'div
            then eval-rpn (cdr (r), cons (car (s) ÷ cadr (s), caddr (s)))
        elseif car (r) = 'mod
            then eval-rpn (cdr (r), cons (car (s) mod cadr (s), caddr (s)))
        else eval-rpn (cdr (r), s) endif
    else s endif
```

THEOREM: eval-rpn-append

$$\text{eval-rpn}(\text{append}(r1, r2), s) = \text{eval-rpn}(r2, \text{eval-rpn}(r1, s))$$

DEFINITION:

```
l1-ind (e, s)
=  if e ∈ N then t
    elseif op1-form-p (e) then l1-ind (cadr (e), s)
    elseif op2-form-p (e)
        then l1-ind (caddr (e), s)
            ∧ l1-ind (cadr (e), cons (eval-exp (caddr (e)), s))
    else t endif
```

THEOREM: l1

$$\text{exp-p}(e) \rightarrow (\text{cons}(\text{eval-exp}(e), s) = \text{eval-rpn}(\text{exp-to-rpn}(e), s))$$

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